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Indian Standard

SPECIFICATION FOR FIXED SILVERED MICA CAPACITORS

(First Revision)

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 7 *September* 1968

Indian Standard
SPECIFICATION FOR FIXED SILVERED MICA CAPACITORS
(First Revision)

Capacitors and Resistors for Electronic Equipment Sectional Committee, ETDC 36

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*Col D. Swaroop was Chairman for the meeting at which this standard was finalized.

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Indian Standard
SPECIFICATION FOR FIXED SILVERED MICA CAPACITORS
(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 10 May 1968, after the draft finalized by the Capacitors and Resistors for Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard relates to fixed mica dielectric capacitors with silver electrodes directly deposited on the mica sheets, intended for use in telecommunication receiving equipment and for similar applications in other electronic equipment. This standard lays down test methods and requirements for judging the electrical, mechanical and climatic properties of this type of capacitors.

0.3 This standard was first published in 1962. The revision of this standard has been undertaken to bring it in line with the later Indian Standards on capacitors and also to be in conformity with the latest documents brought out by IEC on the subject.

The major features of the revision relate to the following:

a) Addition of another grade of capacitors having temperature coefficient value of -200 to $+200$ ppm/deg C.
b) Revised series for voltage rating.
c) Revised method for the measurement of temperature coefficient.
d) Adoption of coded marking for values and tolerances in addition to the colour code.

0.4 This standard requires reference to IS : 589-1961* in which details of the various mechanical and climatic tests prescribed in this standard have been fully covered. Only the appropriate degrees of severity, performance requirements and other special conditions, if any, relating to the climatic and mechanical tests have been included in this standard.

0.5 Tests for resonance frequency have been shown as under consideration, as there is no agreement on the details of this test. It is hoped to include this at a later date in the form of suitable amendment.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

0.6 Assistance has been derived from the following while preparing this standard:

Publication No. 116 Recommendations for receiver-type metallized mica capacitors. International Electrotechnical Commission.

CZ (TIE) 9549 Draft specification for fixed mica dielectric capacitors for use in telecommunication and allied electronic equipment. British Standards Institution.

0.7 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the requirements and methods of tests for judging the electrical, mechanical and climatic properties of fixed mica dielectric capacitors with deposited silver electrodes for use in electronic and telecommunication equipment.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Rated Capacitance — The nominal value of the capacitance indicated by the manufacturer and marked on the capacitor.

2.2 Rated Temperature Range — The range of ambient temperatures for which the capacitor is designed for continuous operation. This corresponds to the temperature limits of the appropriate category.

2.3 Rated Voltage (U_R) (Category Voltage U_C) — The maximum permissible value of the dc voltage or of the sum of the dc voltage and the peak alternating or pulse voltage for which the capacitor is designed to operate at the upper category temperature for a secured endurance. The maximum value of the ac voltage shall not exceed the value determined by the permissible reactive power.

NOTE — The capacitor shall withstand this voltage at any temperature within the rated temperature range, so that for this particular capacitor, the category voltage is equal to the rated voltage.

2.4 Tangent of Loss Angle (Tan δ) — The power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency.

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*Rules for rounding off numerical values (*revised*).

2.5 Temperature Coefficient — Ratio of change in capacitance per degree celsius change of temperature to the capacitance measured at the reference temperature, usually expressed as parts per million per deg C (ppm/deg C) (*see also* 7.3.5).

2.6 Capacitance Drift — The difference between the initial and final values of capacitance after a cycle of specified conditioning of the capacitor (*see also* 7.3.5).

2.7 Type Tests — Tests carried out to prove conformity with the requirements of this specification. These are intended to prove the general qualities and design of a given type of capacitor.

2.8 Acceptance Tests — Tests carried out on samples selected from a lot for the purposes of acceptance of the lot.

2.8.1 *Lot* — All capacitors of the same category and rating, manufactured by the same factory, during the same period.

2.9 Routine Tests — Tests carried out on each capacitor to check requirements which are likely to vary during production.

3. CATEGORIES

3.1 Fixed silvered mica capacitors shall belong to one of the three categories detailed in Table 1 based on their ability to withstand the climatic severities (*see also* IS : 589-1961*).

TABLE 1 CATEGORIES OF FIXED SILVERED MICA CAPACITORS

Climatic Test	Severities		
	Category I	Category II	Category III
Dry heat	+100°C	+85°C	+ 70°C
Cold	−55°C	−40°C	− 10°C
Damp heat (long term)	56 days	56 days	21 days
Damp heat (accelerated)	6 cycles	6 cycles	2 cycles
Rapid change of temperature	+100°C to −55°C	+85°C to −40°C	—
Low air pressure	44 mbar	300 mbar	600 mbar

Note — In case of special requirements when the above categories cannot be applied strictly, other combinations of severity may be agreed between the customer and the manufacturer provided such severities are chosen from IS : 589-1961*.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

4. RATINGS

4.1 Rated Capacitance and Tolerances

4.1.1 *Rated Capacitance* — The values of rated capacitances shall be chosen from IS : 824-1965*.

4.1.2 *Tolerance on Rated Capacitance* — The permissible tolerances on rated capacitance values shall be as follows:

For capacitors of rated capacitance values greater than 10 pF	±1, ±2, ±5, ±10 and ±20 percent subject to a minimum of ±0·5 pF
For capacitors of rated capacitance values of 10 pF and less	±0·5 pF and ±1 pF

4.2 Temperature Coefficient and Capacitance Drift — Fixed silvered mica capacitors shall belong to one of the following four grades specified based on the limits for temperature coefficient and the associated capacitance drift (*see* 7.3.5).

Grade	*Temperature Coefficient* (ppm per deg C)	*Capacitance Drift* (pF)
1	Between −20 and +50	±0·000 5 C +0·1
2	Between −20 and +100	±0·001 C +0·1
3	Between −100 and +100	±0·003 C
4	Between −200 and +200	±0·005 C

NOTE — *C* is the rated capacitance in pF.

4.3 Rated Voltage — The standard values of rated voltage for the capacitors shall be:

100, 350, 500, 750, 1 000, 1 500 and 2 000 V.

5. CONSTRUCTION AND WORKMANSHIP

5.1 Construction

5.1.1 *Terminals* — Unless otherwise specified, the terminals shall either be in the shape of tags, wires or strips, and so coated as to be easily solderable.

5.1.1.1 The length of each wire terminal shall be 25 to 50 mm; the preferred diameter of wires being 0·4 to 0·9 mm.

5.1.1.2 Each strip terminal shall have a cross-sectional area of 0·40 mm^2 with a maximum width of 1·25 mm.

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*Preferred values for resistors and capacitors (*revised*).

5.1.2 *Finish* — Unless otherwise specified, all exposed materials liable to deterioration in moist or other corrosive atmosphere shall be given suitable finish.

5.2 Workmanship — All parts shall be manufactured in a thoroughly workmanlike manner and in accordance with the good engineering practice.

6. MARKING

6.1 Each capacitor shall have the following information clearly marked upon it:

a) Rated capacitance;

NOTE — In the case of direct marking, the rated capacitance shall be marked in picofarads (as pF) when the value is less than 0·01 µF and in microfarads (as µF) when the value is equal to or greater than 0·01 µF.

b) Tolerance on rated capacitance; and

c) Rated voltage.

NOTE 1 — If coded marking of values and their tolerances by means of letters and digits is used, it shall be in accordance with IS : 4114-1967*.

NOTE 2 — When a colour code is used, it shall indicate the rated capacitance, tolerance on rated capacitance and the temperature coefficient and shall be in accordance with Appendix A.

6.1.1 The following particulars, in addition to those specified in **6.1**, shall appear on the carton containing the capacitors:

a) Temperature coefficient and capacitance drift,

b) Category,

c) Mark of origin (manufacturer's name or trade-mark),

d) Date of manufacture which may be in a code form, and

e) Country of manufacture.

NOTE — In cases where a code is used for the components, the marking on the carton shall be by means of letters and figures.

6.2 Any additional marking on the capacitor and/or its carton shall be so applied as not to cause confusion.

6.2.1 The capacitors may also be marked with the ISI Certification mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

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*Coded marking of values of capacitance and resistance by letters and digits.

7. TESTS

7.1 Classification of Tests

7.1.1 *Type Tests* — The procedure for type approval shall be in accordance with IS : 2612-1965*. Unless otherwise agreed, the manufacturer shall submit 48 samples of each category and size equally divided between

a) maximum capacitance at its highest rated voltage, and

b) maximum rated voltage at its highest capacitance.

The sequence of type test shall be in accordance with Appendix B.

7.1.2 *Acceptance Tests* — The acceptance tests shall be carried out on a limited number of samples selected in accordance with the sampling procedure given in IS : 2612-1965* and which have passed the routine tests (*see* **7.1.3**). Two groups of samples, one for non-destructive tests (group A) and the other for destructive tests (group B), shall be selected (*see* Appendix B of IS : 2612-1965*) and the capacitors in each group shall be subjected to the tests specified below:

Group A (Non-destructive):

a) Voltage proof (high voltage) (**7.3.3**),

b) Insulation resistance (**7.3.4**),

c) Temperature coefficient (**7.3.5**), and

d) Scintillation (**7.3.6**).

Group B (Destructive):

a) Robustness of terminations (**7.4.2**),

b) Soldering (**7.4.3**), and

c) Climatic sequence (**7.5.1**).

7.1.3 *Routine Tests* — The following tests shall be carried out on each and every capacitor:

a) Visual examination (**7.4.1**),

b) Capacitance (**7.3.1**),

c) Tangent of loss angle (**7.3.2**), and

d) Voltage proof (high voltage) (as a flash test) (**7.3.3**).

7.2 General Conditions for Tests

7.2.1 *Atmospheric Conditions for Testing* — Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as specified in IS : 589-1961†.

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*Recommendation for type approval and sampling procedures for electronic components.

†Basic climatic and mechanical durability tests for electronic components (*revised*).

7.2.2 *Preconditioning* — Before the measurements are made, the capacitors shall be stored at the measuring temperature and relative humidity for sufficient time to allow the entire capacitor to reach these conditions. The recovery period called for after conditioning is adequate for this purpose.

7.2.3 *Correction to be Applied* — When measurements are made at temperatures other than the specified temperature, the results shall, where necessary, be corrected to the specified temperature. The ambient temperature during tests shall be stated in the test report.

7.2.4 *Drying* — Where drying is called for in this standard, the capacitor shall be conditioned, before measurement is made, for 96 ± 4 hours in a dry oven at a temperature of 55 ± 2°C. The capacitor shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silicagel and shall be kept therein from the time of removal from the oven to the beginning of the specified test.

NOTE — Storage at 55°C may cause a change in the properties of the dielectric with consequent high capacity readings.

7.2.5 *Method of Test or Measurement* — The method used initially for any test or measurement and the equipment used shall, unless otherwise specified, be used for all subsequent applications of that test or measurement. In addition, for all capacitance measurements, the disposition of the capacitors under test and their connecting leads shall be, as far as possible, identical.

7.2.6 *Other Precautions* — During measurements, the capacitors shall not be exposed to draughts, direct sunlight or other influences likely to cause error.

7.3 Electrical Tests

7.3.1 *Capacitance* — The capacitance shall be measured at 20°C or corrected to that temperature by calculation using nominal temperature coefficient. The frequency used for measurement shall be as follows:

For capacitors with a rated capacitance up to and including 1 000 pF	1 Mc/s ± 20 percent
For capacitors where the rated capacitance exceeds 1 000 pF	1 kc/s ± 20 percent

The measuring method shall be of such accuracy that the measuring error does not exceed 10 percent of the lowest tolerance limit on the capacitor. The voltage applied to the capacitor during measurement shall be such as not to cause appreciable heating of the capacitor.

The capacitance shall correspond to the rated capacitance subject to the permissible tolerance.

For capacitors of values less than 10 pF, the method of measurement and the interpretation of results shall be as agreed to between the purchaser and the supplier.

7.3.2 *Tangent of Loss Angle* — This test shall be made under conditions specified in **7.3.1** and with an instrument suitable to measure tan δ values of the order of 10^{-4}.

The tangent of loss angle of the capacitors shall not exceed the following values:

a) For capacitors whose rated capacitance exceeds 1 000 pF	0·001 (at 1 kc/s)
b) For capacitors with a rated capacitance exceeding 100 pF but not exceeding 1 000 pF (inclusive)	0·001 (at 1 Mc/s)
c) For capacitors with a rated capacitance exceeding 5 pF but not exceeding 100 pF (inclusive)	$\frac{(295 - 2C)}{95} \times 0{\cdot}001$ (at 1 Mc/s)

where C is the rated capacitance in pF.

For capacitors of rated values less than 5 pF, the limit and method of measurement shall be agreed to between the purchaser and the supplier.

7.3.3 *Voltage Proof (High Voltage)* — A direct voltage of the appropriate value, specified below shall be applied for a period of one minute, the voltage being applied between the parts specified therein:

a) Between terminals	2·5 U_R
b) Between terminals connected together and the case when metallic or a metal foil wrapped around the body (when the capacitor is insulated) (*see* below)	2·0 U_R

where U_R is the rated voltage.

Insulated capacitors, except those with mounting holes, shall have a metal foil closely wrapped around the body of the capacitor as follows:

a) For those having radial terminals or leads, the foil shall be placed between terminations, leaving a space of 1 mm per kV test voltage between the edge of the foil and each termination.

b) For those having axial leads, the foil shall be placed around the whole body of the capacitor, protruding by at least 5 mm from each end, provided a minimum space of 1 mm per kV test voltage can be maintained between the foil and each termination and, if not, the width of the foil shall be reduced in order to comply with the latter condition. The ends of the foil shall not be folded over the ends of the capacitor.

Insulated capacitors with mounting holes shall be mounted in the normal manner on a metal plate, which extends at least 12·5 mm beyond the mounting face of the capacitor in all directions.

The circuit for this test shall be so chosen that the voltage is applied at once through the internal resistance of the test apparatus. The product of the internal resistance (in megohms) and the rated capacitance value (in microfarads) of the capacitor under test plus any parallel capacitance in the test apparatus shall not exceed one second.

The charging current for the capacitor under test shall not exceed the following limits:

For capacitors with a rated capacitance value less than 100 pF	5 mA
For capacitors with a rated capacitance value equal to or exceeding 100 pF	50 mA

A suitable circuit for this test is given in Appendix C.

After the voltage proof test, there shall be no breakdown of the capacitor, nor any visible deterioration, such as overheating, melting or seepage of impregnant.

When this test is conducted as a routine test, however, the voltage may be applied as a flash say for a period of one second only.

7.3.4 *Insulation Resistance* — Before the measurement of insulation resistance the capacitor shall be fully discharged.

The insulation resistance shall be measured:

a) between terminals,

b) between terminals connected together and the case (when metallic), and

c) if insulated, between terminals connected together and the metal foil wrapped around or the mounting plate as the case may be.

Insulated capacitors, except those with mounting holes, shall have a metal foil closely wrapped around the body of the capacitor as follows:

a) For those having radial terminals or leads, the foil shall be placed between terminations leaving a space of 1 mm per kV test voltage between the edge of the foil and each termination.

b) For those having axial leads, the foil shall be placed around the whole body of the capacitor, protruding by at least 5 mm from each end, provided a minimum space of 1 mm per kV test voltage can be maintained between the foil and each termination and, if not, the width of the foil shall be reduced in order to comply with the latter condition. The ends of the foil shall not be folded over the ends of the capacitor.

Insulated capacitors with mounting holes shall be mounted in the normal manner on a metal plate, which extends at least 12·5 mm beyond the mounting face of the capacitor in all directions.

NOTE — Where the measurement of insulation resistance immediately follows the voltage proof test, it is permissible to use the same arrangement specified in 7.3.3.

The insulation resistance shall be measured with a director voltage equal to:

a) rated voltage or 100 ± 15 V, whichever is lower, for capacitors with a rated voltage below 500 V; and

b) 500 ± 50 V for capacitors with a rated voltage equal to or above 500.

This voltage shall be applied for 60 ± 5 seconds, the insulation resistance being read at the end of that period.

The voltage shall not be applied gradually, but shall be applied at once through the internal resistance of the test apparatus. The product of this internal resistance (in megohms) and the rated capacitance value (in microfarads) of the capacitor under test shall not exceed one second.

The insulation resistance shall be not less than the following:

a) Between terminations	25 000 megohms (for capacitances up to and including 0·04 µF), or 1 000 ohm-farads (for capacitances above 0·04 µF)
b) Between terminations connected together and the case	10 000 megohms

7.3.5 *Temperature Coefficient and Capacitance Drift* — The capacitor shall be dried (*see* 7.2.4) and shall be maintained at each of the following temperatures in turn for 4 hours or until temperature equilibrium is reached:

a) A temperature ($T1$) between 15°C and 35°C

b) Minimum temperature of the rated temperature range ±3°C (T2)

c) The temperature $T1$ [*see* (a)] between 15°C and 35°C

d) Maximum temperature of the rated temperature range ±2°C (T3)

e) The temperature $T1$ [*see* (a)] between 15°C and 35°C

This cycle shall be carried out once; thermal shock shall be avoided.

Capacitance measurement shall be made in accordance with 7.3.1 at each of the temperatures mentioned above after the capacitor has reached that temperature; and with the same electrical test conditions for all the measurements. Care shall be taken to maintain constant capacitance between leads from the test equipment to the capacitors, for all measurements.

The temperature of the chamber at the time of each measurement shall be recorded. The measurement of temperature shall be accurate to 1°C.

The temperature coefficient shall be computed from the formula:

$$\text{Temperature coefficient in ppm/deg C} = \frac{C_{T3} - C_{T2}}{C_{T3}\,(T3 - T2)} \times 10^6$$

where

C_{T3} = capacitance value at test temperature $T3$°C, and

C_{T2} = capacitance value at test temperature $T2$°C.

NOTE 1 — If necessary, the change of the capacitance value of some of the specimens shall be observed at intervals during the temperature cycle to confirm that the temperature coefficient of capacitance is within the limits specified in 4.2, over the temperature range.

NOTE 2 — Capacitors having a capacitance value so low that the accuracy of the measurement of capacitance is of the same order as the variation to be determined, shall be considered as capacitors having an undefined temperature coefficient.

The temperature coefficient determined shall correspond with the rated temperature coefficient taking into account the applicable tolerance.

The capacitance drift shall be given by the largest difference between the capacitance values determined at test temperatures given under (a), (c) and (e) above divided by C_0, the capacitance value at the test temperature given under (c) above.

If the temperatures given under (a), (c) and (e) above differ by more than 0·5 deg the values of capacitances measured at these temperatures shall be corrected to temperature at (a) above using the determined temperature coefficient.

7.3.6 *Short Term Stability (Scintillation)* — This test is applicable only for capacitors of value not exceeding 1 000 pF.

The capacitor shall be connected to form the main capacitance part of the tuned circuit of a stable oscillator operating at a frequency of not less than 1 Mc/s. The capacitor shall be subjected for 30 minutes to a direct voltage equal to half the rated voltage of the capacitor and a superimposed alternating voltage having an rms value of 20 V at the oscillator frequency. Readings shall be taken in the last 10 minutes of this test, the ambient temperature being constant within ± 2 deg C during that time. The output of the oscillator shall be made to beat with a second stable oscillator to produce an audiofrequency signal which shall be observed over the test period.

The observed fluctuations in capacitance value shall not exceed one part in 10 000.

7.3.7 *Resonance Frequency* — Under consideration.

7.4 Mechanical Tests

7.4.1 *Visual Examination* — The capacitor shall be visually examined for compliance with the requirements specified in **5** and **6**.

7.4.2 *Robustness of Terminations*

7.4.2.1 *Tensile test* — This test shall be made in accordance with **7.19.1** of IS : 589-1961*, the loading weight being as follows:

a) For all types of terminations except wire terminations — 2 kg

b) For wire terminations:

Cross-Sectional Area of Wire mm^2	*Load* kg
Exceeding 0·5	2
Exceeding 0·2, up to and including 0·5	1
Up to and including 0·2	0·5

NOTE — The body of the capacitor shall be clamped in such a way that the coating, if any, of the capacitor does not peel off during the test.

There shall be no visible damage after this test.

7.4.2.2 *Bending test*

a) *Wire or strip terminations* — The bending test on wire or strip terminations shall be carried out in accordance with **7.19.2.2** of IS : 589-1961*. Care shall be taken to ensure that the bend occurs at a point 6 mm away from the point of emergence of the wire or strip from the component and around a radius of 0·75 mm. Suitable arrangements to ensure this requirement are shown in Fig. 1. Each termination shall withstand two consecutive bends without visible damage to the capacitor.

b) *Tag terminations* — The bending test on tag terminations shall be carried out in accordance with **7.19.2.3** of IS : 589-1961*. Each soldering tag shall withstand two consecutive cycles of bending without visible damage to the capacitor.

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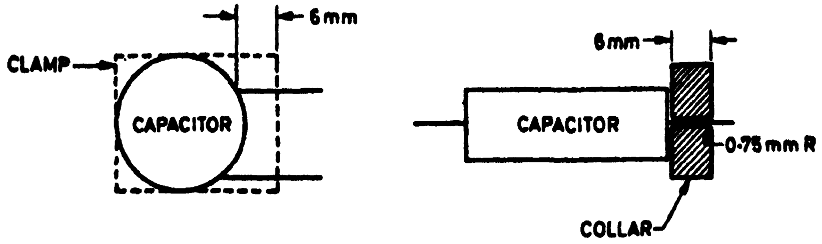
*Basic climatic and mechanical durability tests for electronic components (*revised*).



1A DISC TYPE 1B TUBULAR TYPE

FIG. 1 ARRANGEMENT FOR BEND TEST

7.4.3 *Soldering* — The capacitor shall be dried (*see* **7.2.4**) and the capacitance and tangent of loss angle shall then be measured.

The capacitor shall be subjected to the solder bath test specified in **7.18.2** of IS : 589-1961*.

NOTE — For capacitors with tag terminations, the soldering iron test in accordance with **7.18.3** of IS : 589-1961* may be applied, in case the solder bath test is not practicable.

In the case of capacitors stated by the manufacturer to be suitable for use with printed wiring, the wire terminations shall be immersed up to 3·5 mm from the point where the termination emerges from the body of the capacitor.

The capacitor shall be visually examined and there shall be no apparent damage.

The capacitance and tangent of loss angle shall then be measured between ½ hour and 1 hour after immersion in the solder bath. The change of capacitance compared with the value measured above shall not exceed 0·5 percent or 0·5 pF, whichever is greater, and there shall be no change in the value of tangent of loss angle.

7.4.4 *Vibration* — The capacitors shall be mounted in accordance with **7.6.4.1** of IS : 589-1961* taking care that the terminal wires are not stressed and in such a manner that equal numbers are vibrated along each of the three principal axes. The capacitors shall be subjected to the vibration (fatigue) test in accordance with **7.6.6** of IS : 589-1961* with the following severities:

Category	*Severity According to Table 1 of IS : 589-1961**
Categories 1 and 2	Severity III
Category 3	Severity I

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

After the test, the capacitors shall be visually examined. There shall be no visible damage.

7.4.5 *Bump* — The capacitors shall be mounted as specified in **7.4.4** and subjected to the bump test in accordance with **7.5.1** of IS : 589-1961*.

After the test, the capacitors shall be visually examined. There shall be no visible damage.

7.5 Climatic Tests

7.5.0 *Preconditioning* — Preconditioning shall be done according to **7.2.2**.

7.5.1 *Climatic Sequence*

7.5.1.1 *Initial measurements* — The following initial measurements shall be carried out:

a) Visual examination,
b) Capacitance,
c) Tangent of loss angle, and
d) Insulation resistance.

7.5.1.2 *Dry heat* — The capacitors shall be subjected to dry heat test in accordance with **7.2** of IS : 589-1961*, the temperature of the test chamber being maintained at the appropriate upper category temperature.

After recovery, the capacitors shall be visually examined. There shall be no apparent damage.

7.5.1.3 *Damp heat* (*accelerated*), *first cycle* — The capacitors shall be subjected to the first cycle of damp heat (accelerated) test in accordance with **7.4** of IS : 589-1961*.

After recovery, the capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

7.5.1.4 *Cold* — The capacitors shall be subjected to the cold test in accordance with **7.1** of IS : 589-1961*, the temperature of the test chamber being maintained at the appropriate lower category temperature.

After recovery the capacitors shall be visually examined. There shall be no apparent damage and the marking shall be legible.

7.5.1.5 *Low air pressure* — The capacitors shall be subjected to low air pressure test in accordance with **7.12** of IS : 589-1961*. The test chamber shall be maintained at an air pressure appropriate to the category of the capacitor and in a temperature range of 15 to 35°C. The duration of exposure shall be one hour.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

While still at the specified low pressure and during the last 5 minutes of the one-hour test period, a direct voltage shall be applied to the terminals of the capacitors. The test voltage will depend on the construction of the capacitor, and its value shall be agreed to between the purchaser and the supplier. When the capacitor has a metallic case, half the lot of capacitors shall have the voltage applied between terminals and the other half of the lot shall have the voltage applied between terminals connected together and the case.

During and after this test, there shall be no deformation of the case or seepage of impregnant and no sign of breakdown or flash-over.

7.5.1.6 *Damp heat (accelerated), remaining cycles* — The capacitors shall be subjected to the remaining cycles of the damp heat (accelerated) test in accordance with **7.4** of IS : 589-1961*. The number of cycles shall be appropriate to the category of capacitors under test.

NOTE — The remaining damp heat (accelerated) cycles are as follows:

Category 1 — 5 cycles
Category 2 — 5 cycles
Category 3 — 1 cycle

After recovery the capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

7.5.1.7 *Final measurements* — The capacitance, tangent of loss angle and insulation resistance shall be measured at the end of the climatic sequence.

The change of capacitance compared with the value measured in **7.5.1.1** shall not exceed the following limits in percent or in picofarads, whichever is greater:

Grade	*Temperature Coefficient of Capacitance in ppm/deg C*	*Maximum Permissible Change of Capacitance*
Grade 1	— 20 to + 50	0·5 percent or 0·5 pF
Grade 2	— 20 to + 100	1·0 percent or 1·0 pF
Grade 3	— 100 to + 100	1·0 percent or 1·0 pF
Grade 4	— 200 to + 200	1·0 percent or 1·0 pF

The tangent of loss angle shall remain within the limits specified in **7.3.2**.

The insulation resistance shall not be less than the following values:

a) Between terminations	12 500 megohms for capacitors up to 0·04 µF, and 500 ohm-farads for capacitors equal to and above 0·04 µF
b) Between terminations and the body	10 000 megohms

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

7.5.2 *Damp Heat (Long Term)* — The capacitors shall be subjected to damp heat (long term exposure) test in accordance with **7.3** of IS : 589-1961*. The duration of the exposure shall be appropriate to the category of the capacitor under test.

During the whole period of this test a direct voltage shall be applied to the terminals of half the number of capacitors. This voltage shall be equal to 100 V or half the rated voltage of the capacitor, whichever is lower.

After recovery the capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

Capacitors subjected to voltage shall show no short circuit nor open circuit.

The following parameters of the capacitors not subjected to voltage shall then be measured:

a) Capacitance,

b) Tangent of loss angle, and

c) Insulation resistance.

The change of capacitance compared with the value measured in **7.5.1.1** shall not exceed the following limits in percent or in picofarads, whichever is greater:

Grade	*Temperature Coefficient of Capacitance (ppm/deg C)*	*Maximum Permissible Change of Capacitance*
Grade 1	— 20 to + 50	0·5 percent or 0·5 pF
Grade 2	— 20 to + 100	1 percent or 1 pF
Grade 3	— 100 to + 100	1 percent or 1 pF
Grade 4	— 200 to + 200	1 percent or 1 pF

The tangent of loss angle shall remain within the limits specified in **7.3.2**.

The insulation resistance shall be not less than the following values:

a) Between terminations	12 500 megohms for capacitors up to 0·04 µF, and 500 ohm-farads for capacitors equal to and above 0·04 µF
b) Between terminations and the body	10 000 megohms

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

7.5.3 *Rapid Change of Temperature* — This test is applicable to capacitors of categories 1 and 2 only. The capacitance of the capacitors shall be measured.

The capacitors shall be subjected to rapid change of temperature test in accordance with **7.14** of IS : 589-1961* for one cycle. The upper temperature shall be the appropriate upper category temperature while the lower temperature shall be the appropriate lower category temperature.

After recovery the capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The capacitance of the capacitors shall then be measured. The change of capacitance compared with the value measured above shall not exceed one percent or 1·0 pF, whichever is greater.

7.5.4 *Mould Growth* — This test shall be carried out in accordance with **7.9** of IS : 589-1961* and shall satisfy the requirements specified therein.

7.6 Storage (Normal) Test — This test shall be carried out in accordance with **7.8.1** of IS : 589-1961*. At the end of storage for the specified period, the capacitors shall be visually examined. There shall be no apparent damage and the marking shall be legible.

The capacitance, tangent of loss angle and insulation resistance shall then be measured.

The change of capacitance compared with the value measured in **7.3.1** shall not exceed the following limits in percent or in picofarads, whichever is greater:

Grade	*Temperature Coefficient of Capacitance in ppm/deg C*	*Maximum Permissible Change of Capacitance*
Grade 1	—20 to + 50	0·5 percent or 0·5 pF
Grade 2	—20 to + 100	1·0 percent or 1·0 pF
Grade 3	—100 to + 100	1·0 percent or 1·0 pF
Grade 4	—200 to + 200	1·0 percent or 1·0 pF

The tangent of loss angle and insulation resistance shall remain within the limits specified in **7.3.2** and **7.3.4** respectively.

7.7 Endurance Test — The capacitance, tangent of loss angle and insulation resistance of the capacitors shall be measured.

The capacitors shall be subjected to an endurance test of 1 000 hours in an atmosphere maintained at the upper category temperature with

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

a direct voltage of 1·5 times the rated voltage applied between the terminals. The voltage shall be applied to the capacitor individually through a resistor whose value is approximately 200 ohms per applied volt.

The capacitors shall be placed in the test chamber in such a manner that no capacitor is within 25 mm of any other capacitor. The capacitors shall not be heated by direct radiation and the circulation of the air in the chamber shall be adequate to prevent the temperature from departing by more than ± 3 deg C from the specified temperature at any point where capacitors are placed. It shall be assumed in this test that the temperature of the capacitors is the same as the specified temperature.

The capacitor shall be considered to have failed when a temporary or permanent short circuit occurs in the capacitor or between any electrode and the case.

After the specified period of exposure, the capacitors shall be allowed to cool to standard atmospheric conditions for testing. They shall then be subjected to two cycles of damp heat (accelerated) test (*see* **7.5.1.6**) (applicable to categories 1 and 2 capacitors only).

The capacitors shall then be visually examined. There shall be no visible damage and the marking shall be legible.

The capacitance, the tangent of loss angle and the insulation resistance shall then be measured. The change of capacitance compared with the value measured above shall not exceed the following limits in percent or in picofarads, whichever is the greater:

Grade	*Temperature Coefficient of Capacitance* (ppm/deg C)	*Maximum Permissible Change of Capacitor*
Grade 1	— 20 to + 50	0·5 percent or 0·5 pF
Grade 2	— 20 to + 100	1·0 percent or 1·0 pF
Grade 3	— 100 to + 100	1·0 percent or 1·0 pF
Grade 4	— 200 to + 200	1·0 percent or 1·0 pF

The tangent of loss angle and insulation resistance shall not differ from the values measured above.

APPENDIX A

(*Clause* 6.1)

COLOUR CODE FOR FIXED SILVERED MICA CAPACITORS

A-0. GENERAL

A-0.1 The colour code given in **A-1** is applicable to mica moulded capacitors only.

A-0.2 Marking by colour code is optional and it is left to the manufacturers to indicate the essential information required (*see* **6.1**) by any other suitable means.

A-1. COLOUR CODE

A-1.1 When the capacitance value, tolerance on capacitance and temperature coefficient are indicated by a colour code, the six-dot code given in Table 2 shall be used.

A-1.1.1 The capacitance values shall be expressed in picofarads and the temperature coefficient in parts per million per degree celsius.

A-1.2 The dots shall be arranged in two rows of three as shown in Fig. 2. An indication, giving without ambiguity the order in which the dots are to be read, should be given.

A-1.2.1 The reading of the colour code shall be from the left hand top corner, clockwise.

A-1.2.1.1 Typical examples of marking for unambiguous reading of the dots are shown in Fig. 2.

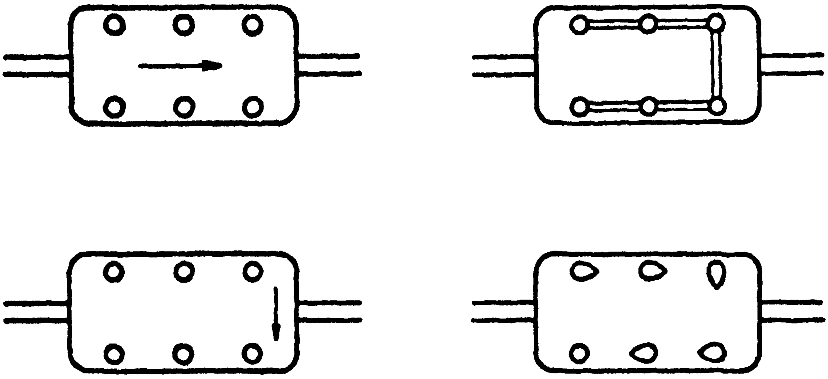


FIG. 2 TYPICAL EXAMPLES OF SIX-DOT COLOUR CODE

A-1.3 Any additional coding on capacitors shall be so applied as not to be confused with the coding for capacitance value, tolerance on capacitance and temperature coefficient.

A-1.3.1 While the colour code specified in **A-1.1** and **A-1.2** shall be given on one side of the capacitor, on the reverse side a three-dot colour code may be employed to indicate the dc working voltage, category and vibration grade (*see* Fig. 3), if additional marking of those particulars also is desired.

NOTE — Allocation of colours for marking the different severities in the three-dot colour code on the reverse side of the capacitor is under consideration.

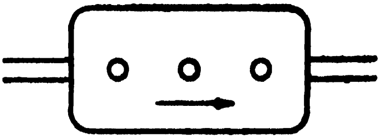


FIG. 3 THREE-DOT CODE (ON REVERSE SIDE) FOR ADDITIONAL MARKINGS

TABLE 2 COLOUR CODE FOR MARKING THE CAPACITORS

(*Clause* A-1.1)

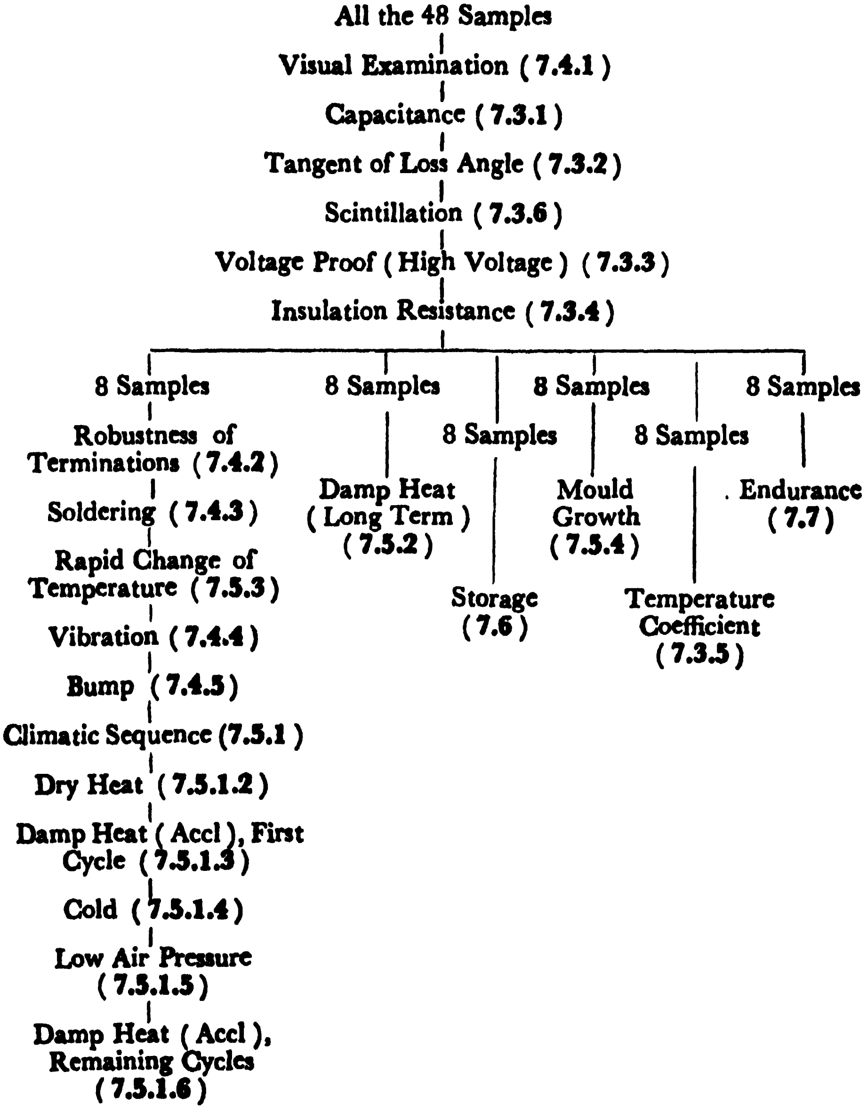
Colour	Capacitance Value (in Picofarads)				Tolerance		Temperature Coefficient in ppm/deg C
		First Figure	Second Figure	Multiplier	Rated Capacity Exceeding 10 pF	Rated Capacity Up to and Including 10 pF	
	*First dot	Second dot	Third dot	Fourth dot	Fifth dot		Sixth dot
Black		—	0	10^0	±20%	—	—
Brown		1	1	10^1	± 1%	—	—
Red		2	2	10^2	± 2%	—	−200 to +200
Orange		3	3	10^3	—	—	−100 to +100
Yellow		4	4	10^4	—	—	−220 to +100
Green		5	5	—	—	—	− 20 to + 50
Blue		6	6	—	—	—	—
Violet		7	7	—	—	—	—
Grey		8	8	—	—	—	—
White		9	9	—	—	—	—
Gold		—	—	10^{-1}	± 5%	±0·5 pF	—
Silver		—	—	10^{-2}	±10%	±1 pF	—

*Significance of the first dot is under consideration.

APPENDIX B

(*Clause* 7.1.1)

SEQUENCE OF TYPE APPROVAL TESTS


All the 48 Samples
Visual Examination (7.4.1)
Capacitance (7.3.1)
Tangent of Loss Angle (7.3.2)
Scintillation (7.3.6)
Voltage Proof (High Voltage) (7.3.3)
Insulation Resistance (7.3.4)
8 Samples
Robustness of Terminations (7.4.2)
Soldering (7.4.3)
Rapid Change of Temperature (7.5.3)
Vibration (7.4.4)
Bump (7.4.5)
Climatic Sequence (7.5.1)
Dry Heat (7.5.1.2)
Damp Heat (Accl), First Cycle (7.5.1.3)
Cold (7.5.1.4)
Low Air Pressure (7.5.1.5)
Damp Heat (Accl), Remaining Cycles (7.5.1.6)
8 Samples
Damp Heat (Long Term) (7.5.2)
8 Samples
Storage (7.6)
8 Samples
Mould Growth (7.5.4)
8 Samples
Temperature Coefficient (7.3.5)
8 Samples
. Endurance (7.7)

APPENDIX C

(*Clause* 7.3.3)

TEST CIRCUIT FOR VOLTAGE PROOF TEST

C-1. CIRCUIT

C-1.1 A suitable circuit for the voltage proof test is given in Fig. 4.

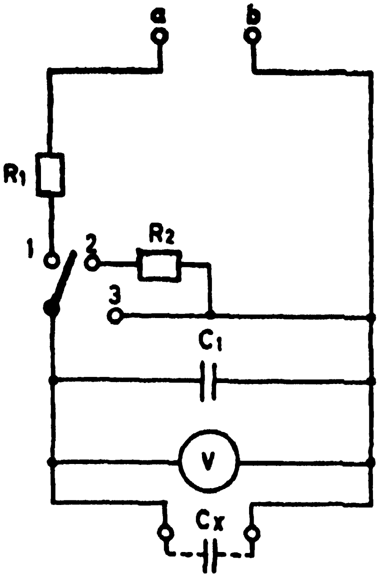


FIG. 4 SUITABLE CIRCUIT FOR THE VOLTAGE PROOF TEST

C-1.1.1 The resistance of the voltmeter shall be not less than 10 000 ohms/volt.

C-1.1.2 The capacitance C_1 shall be at least ten times of C_x.

C-1.1.3 The resistance R_1 and R_2 shall be such that the initial charging and discharging current of C_x does not exceed 5 mA for capacitors of capacitance value less than 100 pF, and 50 mA for capacitors of capacitance value 100 pF and above at the highest test voltage.

Further, R_1 and R_2 should have a value such that

$$R_1 (C_1 + C_x) \leq 1 \text{ second}$$
$$R_2 (C_1 + C_x) \leq 1 \text{ second}$$

in which C_1 and C_x are in farads and R_1 and R_2 in ohms.

C-1.1.3.1 R_1 includes the internal resistance of the power supply also

C-2. PROCEDURE

C-2.1 The switch shall be connected to R_2. The two terminals indicated at the top of the diagram, shall be connected to variable dc supply of adequate power which shall be adjusted to the required test voltage.

C-2.2 The switch shall then be connected to R_1 so that the capacitors C_1 and C_x are charged.

C-2.3 The switches shall remain in this position for the time specified in **7.3.3** after the test voltage has been reached. The capacitor shall then be discharged by connecting the switch to R_2.

C-2.4 As soon as the voltmeter reading has fallen to zero, the capacitors shall be short-circuited and C_x shall be disconnected.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	Pascal	Pa	1 Pa = 1 N/m^2

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AMENDMENT NO. 1 MAY 1978

TO

IS : 2001-1968 SPECIFICATION FOR FIXED SILVERED MICA CAPACITORS

(First Revision)

Alterations

[*Page* 7, *clause* **6.1**(c), *Note* 1, *line* 2] — Substitute ' IS : 8186-1976* ' *for* ' IS : 4114-1967* '.

(*Page* 7, *foot-note with* ' * ' *mark*) — Substitute the following for the existing matter:

' *Marking codes for values and tolerances of resistors and capacitors. '

(LTDC 15)